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(54) Method for moving equipment in a well system

(57) A method and well system are disclosed which allow service or other equipment to be moved into, through and/or from the well system whilst production of oil and/or gas can continue during at least part of the period during which the equipment is moved or used in the well system. The well system thereto comprises a plurality of entrance points at the earth surface and a system of underground wellbores which provide a sub-surface connection between said entry points so that production of oil and/or gas can continue via at least one of said entrance points whilst equipment is moved into, through and/or from the well system via another entrance point.

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Description

The invention relates to a method for moving equipment into, through and/or from a well system for the production of hydrocarbon fluids and to a well system in which the method can be applied.

In many cases there is a need for moving equipment into, through and/or from oil or gas production wells after start-up of the well, for example to install or remove a sand screen or measuring equipment, or to plug a well section or to drill a further extension or well-branch.

Generally these activities require killing of the well by pumping a high density liquid into the well whereupon so-called X-mas tree can be removed from the wellhead and the equipment can be moved into, through and/or from the well. Occasionally it is possible to apply an underbalanced drilling or workover technique where the downhole fluid pressure in the well remains lower than the reservoir fluid pressure, but in any case the activities require extensive precautions to avoid a blow-out and will generate substantial production losses over a significant period of time.

An object of the present invention is to provide a method for moving equipment into, through and/or from a well system for the production of hydrocarbon fluids which allows an easy and safe access to the well system at any time and which results in but lower production losses.

Therefore, in accordance with the invention there is provided a method for moving equipment into, through and/or from a well system for the production of hydrocarbon fluids, which well system comprises a plurality of entrance points at or near the earth surface and a system of one or more underground wellbores which provide a subsurface connection between said entrance points, the method comprising moving equipment into, through and/or from the well system via a first of said entrance points whilst production of hydrocarbon fluids takes place via another entrance point during at least part of the period that the equipment is moved into, through and/or from the well system.

Optionally, said first and any other entrance points are wellheads of hydrocarbon fluid production wells and the production of hydrocarbon fluids via the wellhead that forms the first of said entrance points is interrupted or minimized during at least part of the period that the equipment is moved into, through and/or from the well system.

Alternatively, the first of said entrance points is a dedicated equipment launch and retrieval point not used for normal production operations.

Suitably, the equipment comprises drilling, services, monitoring and/or control equipment which is moved through the well system by carrier means which are connected to surface power supply and/or control facilities via an electrical, fibre optical, hydraulic, or other umbilical conduit which passes through the first of said entrance points.

In such case the carrier means optionally comprises plugging equipment which temporarily provides a plug which blocks or reduces flow of fluids from the well system towards the first of said entrance points during at least part of the period that the carrier means and/or other equipment are used in or moved into, through or from the well system.

The well system according to the invention comprises a plurality of entrance points at or near the earth surface and a system of underground wellbores which provides a subsurface connection between said entrance points, wherein at least a first of said entrance points is provided with means for moving equipment into, through and/or from the well system whilst production of hydrocarbon fluids takes place via another entrance point during at least part of the period that the equipment is moved into, through and/or from the well system.

The invention also relates to a method for the phased development of such a well system. The method comprises drilling and completing a hydrocarbon fluid production well via a well entrance point at or near the earth surface and initiating the production of hydrocarbon fluids via that entrance point; and subsequently drilling another well via another entrance point at or near the earth surface such that the wellbores of the wells intersect and form a subsurface corridor via which equipment can be moved, wherein production of hydrocarbon fluids via the already completed well continues during at least part of the period that the other well is being drilled and/or completed. The process of drilling further wellbores may continue after completion of said other well whilst production via at least one entrance point continues.

It is observed that US patent specification No. 4,390,067 discloses the use of a pattern of interconnected horizontal and vertical wells in which steam is injected to generate heated corridors in a viscous oil bearing formation. In this known system steam is injected via some wellheads and oil is produced, using beam pumps installed at some of the other wellheads.

US patent specification No. 4,283,088 discloses the use of an underground working tunnel and workings from where heat injection and oil production wells are drilled into a viscous oil bearing formation by mining personnel operating in the tunnel and workings. The tunnel and workings are ventilated and perform as a subsurface work area from which a series of generally upwardly oriented heat injection and oil production wells are drilled. The tunnel and workings therefore do not form part of the well system itself.

Furthermore, International patent application No. PCT/GB94/00515 (publication WO 94/21889) discloses in Fig. 2 that a U-shaped well may be used to facilitate geothermal energy from an underlying layer to enhance the production of fluids from an underground reservoir.

The invention will now be described in more detail

with reference to the accompanying drawing which shows a schematic perspective view of a well system according to the invention.

The well system comprises a first wellhead 1 and a second wellhead 2. The wellheads 1 and 2 are located at the earth surface 3 and interconnected via a system of underground wellbores. The system of wellbores comprises of a first and a second vertical wellbore 4 and 5 and a pair of substantially horizontal wellbores 6 and 7, which interconnect the vertical wellbores 4 and 5 at different depths. Furthermore a pair of wellbranches 8 and 9 have been drilled from the first vertical wellbore 4 and a pair of wellbranches 10 and 11 have been drilled from the upper horizontal wellbore 6.

The well system traverses upper and lower oil and/or gas bearing formations 12 and 13 that are shown in the drawing as shaded areas. Inflow of oil and/or gas into the well system takes place at inflow zones 14 and 15 which are depicted in the drawing as dark shaded areas.

It is observed that the inflow zones 14 and 15 could each be separate oil and/or gas reservoirs.

The well system is equipped with a series of valves 16 which in the illustration shown are closed and thereby prevent inflow of oil and/or gas into the first vertical wellbore 4 towards the first wellhead 1. A service equipment carrier tool 17 has been lowered into the lower horizontal wellbore 7.

The tool 17 is connected to power and control means (not shown) at the earth surfaces 3 via an umbilical cable 18 which has been reeled into the well system from a reeling drum 19. The first wellhead 1 is provided with a lubricator 20 which provides a fluid tight seal around the umbilical cable 18.

The configuration shown allows production of oil and/or gas to continue via the inflow regions 14 and the second vertical wellbore 5 towards the second wellhead 2 as illustrated by the black areas in the well system and arrows 21 while the equipment carrier tool 17 and the equipment carried thereby is moved via the first wellhead 1 into, through and from the well system.

The service equipment carried by the carrier tool 17 may consist of logging, cleaning, maintenance, inspection drilling and/or other equipment which can be used downhole over prolonged periods while production via the second wellhead 2 continues. The equipment can be used both during well completion and production operations, for example for well inspection and maintenance, production monitoring (including well logging) and well inflow control, transportation of components into and from the well system, deployment of sensors and for the assembly and disassembly of downhole equipment.

The tool 17 may be equipped with wheels or other propulsion means (not shown) and a nose section which comprises an expandable seal and which is secured to the tool body as an axially slidable plunger so that the tool can propel itself forward as a kind of inchworm into a wellsection which has not yet been isolated by a valve or other flow stopper.

Furthermore the carrier tool 17 may itself be used to install or set valves 16 or sealing plugs at branch points or other locations where a temporary or permanent flow interruption is required.

If access to the well system via the second wellhead 2 is needed, for example if service or other operations are to be carried out in the wellbranches 11, the tool may be lowered into the well system by mounting the drum 19 and lubricator 20 on top of the second wellhead 2.

In such case production from the lower horizontal wellbore 7 and the wellbranches 8 and 9 may continue via the first wellhead 1.

It will be understood that instead of using an umbilical 18 for power supply to and data transmission from and to the tool 17 and the equipment carried thereby the tool may contain its own power supply and a wireless data transmission link.

Furthermore, power and or data transmission may be facilitated by transmitting an electromagnetic field via the well tubing or casing or a conductor which is permanently embedded in the well and by providing the tool 17 with an inductive coupler which serves as a movable electrical contact. The absence of an umbilical 18 would obviate the need for the reeling drum 19 and lubricator 20 and in such case the tool 17 can be inserted into the well system by sluices (not shown) in the wellheads 1 and 2.

In order to avoid the use of an umbilical cable 18 and/or frequent insertion of the tool 17 into the well system and removal therefrom the well system may be provided with a series of downhole base points (not shown). Such downhole base points may be formed by areas where the wellbore and/or production tubing inside the wellbore has an enlarged diameter or side pocket which serves as a dock-in station for the tool 17 and/or the equipment carried thereby during periods when they are not in use.

The downhole base point may be provided with dedicated links for power and communication to the surface 3. If the tool 17 and equipment are powered by batteries, the batteries can be rechanged at the base point or points. If the tool 17 and/or equipment comprise sensors and a memory for storing data gathered then the data thus gathered can be unloaded at a base point and transmitted to data processing equipment at the surface. In such case the tool 17 itself may be used to as a shuttle that reloads batteries of permanently installed sensors or other equipment in the vicinity of a base point and to unload data collected thereby and sequentially transmit such data to the surface. Furthermore the batteries of the tool itself may be used to provide power downhole, for example to set a valve or to actuate a drilling or other device.

The use of the method and well system according to the invention is not limited to a well system with two

wellheads 1 and 2 where production via one of the wellheads 2 can be continued whilst service operations are carried out via the other wellhead 1. The well system may also comprise three or more wellheads and only one of the wellheads may be equipped with launch and sluice means for launching equipment into the well system. This wellhead may for example be located at the deck of an offshore platform and be a dedicated entry point for launching equipment into the well system and for manipulating the equipment downhole, whilst no oil and/or gas is produced via this entry point during normal operations. The other wellheads of such a well system could be arranged subsea and produce oil and/or gas towards production facilities at the platform. In such case chemicals, steam or other injection fluids may be injected into the well system via the equipment entry point and in case processing facilities at the platform are occasionally overloaded or out of service oil and/or gas could be reinjected into the well system via the equipment entry point. If a tool 17 is to be inserted into a subsea wellhead this may be accomplished by using an underwater vehicle.

It will also be understood that the well system can be developed in phases. The well system shown in the drawing may initially be developed by drilling the second vertical well-bore 5 and the lower horizontal wellbore 7.

On the basis of downhole reservoir imaging techniques carried out from the already drilled wellbores 5 and 7 the upper horizontal wellbore and wellbranches 10 and 11 are drilled accurately into the reservoir formation(s).

Subsequently production of oil and/or gas is started via the second wellhead 2 and accurate production and reservoir data can be collected. After evaluating these data the first wellbore 4 is drilled and linked to the horizontal wellbores 6 and 7 such that these sections provide a downhole corridor between the vertical wellbores 4 and 5 through which equipment can be moved.

Then it is possible to further expand the wellsystem by drilling and completing the wellbranches 8 and 9 whilst production of oil or gas continues via the second wellhead 2.

Subsequent to commencing oil or gas production via both wellheads 1 and 2 the wellsystem can be further expanded by using re-entry drilling techniques where the equipment is moved into and from the wellsystem via one of the wellheads 1 or 2 whilst production via the other wellhead 1 or 2 continues.

Thus production constraints can be removed continuously and the flow performance of the wells can be optimized at any time. Development flexibility may also be improved by connecting one well with spare vertical flow capacity to the production face of an adjacent well where production is restricted by vertical flow constraints.

Furthermore, the wellheads need not to be spaced apart as illustrated in the drawing. The well system may also comprise a pair of parallel or co-axial tubings in a single vertical well, which tubings are interconnected downhole via a wellbore that forms a closed loop from and towards the vertical well. If in such case the well is equipped with co-axial tubings it may generally be desirable to use the inner tubing for the transport of the carrier tool and/or other equipment into and from the well system and to use the surrounding tubing or tubings for the production of oil and/or gas.

These and other features, objects and advantages of the method and system according to the present invention will become apparent from and/or are further disclosed in the accompanying claims, abstract and drawing.

Claims

1. A method for moving equipment into, through and/or from a well system for the production of hydrocarbon fluids, which well system comprises a plurality of entrance points at or near the earth surface and a system of one or more underground wellbores which provide a subsurface connection between said entrance points, the method comprising moving equipment into, through and/or from the well system via a first of said entrance points whilst production of hydrocarbon fluids takes place via another entrance point during at least part of the period that the equipment is moved into, through and/or from the well system.

2. The method of claim 1, wherein said first and any other entrance points are wellheads of hydrocarbon fluid production wells and the production of hydrocarbon fluids via the wellhead that forms the first of said entrance points is interrupted or minimized during at least part of the period that the equipment is moved into, through and/or from the well system.

3. The method of claim 1 or 2, wherein the equipment consists of drilling, service, maintenance, monitoring and/or control equipment which is moved through the well system by carrier means which are connected to surface power supply and/or control facilities via an electrical, fibre optical hydraulic, or other umbilical conduit which passes through the first of said entrance points.

4. The method of claim 3, wherein the carrier means are provided with plugging equipment which temporarily provides a plug which blocks or reduces flow of fluids from the well system towards the first of said entrance points during at least part of the period that the carrier means and/or other equipment are used in or moved into, through or from the well system.

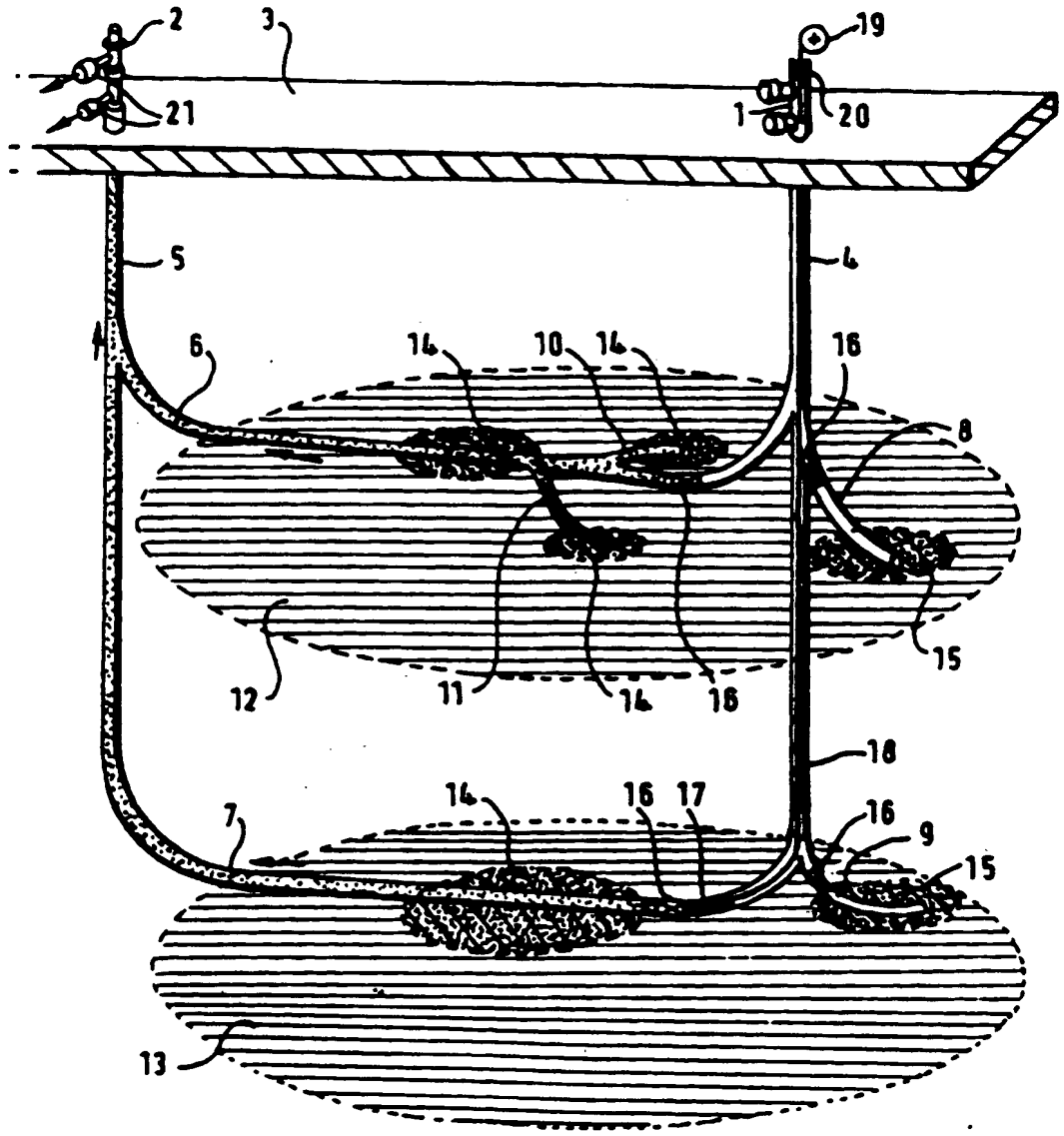
5. A well system for production of hydrocarbon fluids which comprises a plurality of entrance points at the

earth surface and a system of underground wellbores which provides a subsurface connection between said entrance points, wherein at least a first of said entrance points is provided with means for moving equipment into, through and/or from the well system whilst production of hydrocarbon fluids takes place via another entrance point during at least part of the period that the equipment is moved into, through and/or from the well system.

6. The well system of claim 5, wherein the entrance points are mutually spaced and the system of underground wellbores comprises at least one central wellbore which provides a subsurface connection between at least two entrance points through which equipment can be moved and optionally a number of wellbranches which are directly or indirectly connected to a central wellbore.

7. The well system of claim 6, wherein the system comprises a number of downhole base points in which equipment and/or carrier means can be docked while production of hydrocarbon fluids via the well system takes place and in which battery packs of the equipment and/or carrier means can be reloaded and data gathered by the equipment and/or carrier means can be unloaded and transmitted to data processing equipment at the earth surface.

8. A method for the phased development of a well system according to claim 5 or 6, the method comprising drilling and completing a hydrocarbon fluid production well via a well entrance point at or near the earth surface and initiating the production of hydrocarbon fluids via that entrance point; and subsequently drilling another well via another entrance point at or near the earth surface such that the wellbores of the wellbores of the wells intersect and form a subsurface corridor via which equipment can be moved, wherein production of hydrocarbon fluids via the already completed well continues during at least part of the period that the other well is being drilled and/or completed.



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EUROPEAN SEARCH REPORT

Application Number
EP 97 20 1266

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	US 4 532 986 A (D.S. MIMS) * column 2, line 64 - column 5, line 68 * * figures *	1,3-5 2,6,8	E21B43/30 E21B23/00
Y,D	US 4 390 067 A (B.T. WILLMAN) * column 4, line 67 - column 6, line 35 * * figures 1A,1B *	2	
Y	US 3 241 611 A (J.L. DOUGAN) * column 3, line 1 - line 40 * * figure 1 *	6	
Y	US 5 246 273 A (E.C. ROSAR) * column 9, line 20 - column 10, line 11 * * figure 1 *	8	
X	US 5 450 902 A (C.M. MATTHEWS) * column 14, line 60 - column 15, line 18 * * column 19, line 44 - column 20, line 21 * * column 24, line 14 - line 25 * * figure 4 *	1,2,5,6 7	TECHNICAL FIELDS SEARCHED (Int.Cl.6) E21B
Y	US 4 757 859 A (M.A. SCHNATZMEYER) * abstract *	7	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 September 1997	Leitner, J

CATEGORY OF CITED DOCUMENTS

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